Ocean Data Management at NCDC

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1. PROJECT SUMMARY

The project "Ocean Data Management at NCDC" directly supports the mission of NCDC (NOAA National Climatic Data Center): "To provide stewardship and access to the Nation's resource of global climate and weather related data and information, and assess and monitor climate variation and change." This in turn directly supports the NOAA Mission: "To understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs."

NCDC plays an active and important role in the national and international climate change monitoring and assessment programs [e.g., the US Climate Change Science Program (CCSP) Syntheses]. Climate change monitoring and assessment require meteorological and marine data over both land and ocean. Changes of environmental variables at and near the marine surface are important since they occur over approximately 70% of the Earth's surface and contain important climate change signals. Due to the drastic property differences between water and air (e.g., density and heat capacity), huge amount of water, energy, momentum and gases (e.g., carbon dioxide) are constantly exchanged at the turbulent air-sea interface. These exchanges regulate the weather in the short term and the climate change in the long term. Thus, NCDC has been actively archiving, serving and utilizing the world's surface marine data, and it will need to continue to do so.

Modern day Global Ocean Observing System (GOOS) consists of multiple platforms and instruments (both in-situ and remote sensing). Each of these observations contributes to the understanding and assessment of climate change signals. However, individual instrument observations have limitations in coverage (in both time and space) and limitations on accuracy. To maximize benefits and integrally use all the available observations, it is necessary to blend them together to produce higher resolution and higher accuracy products. For example, research on global water and energy budgets and numerical weather and ocean forecasts demand increasingly higher resolution forcing data (better than daily and 50 km; e.g., WMO/TD-No. 1036, 2000; Curry et al. 2004). The recent international Global Earth Observation System of Systems (GEOSS) and Global Climate Observing System (GCOS) also called for optimal combinations of the above platforms for integrated global observing system and service.

There are typically three types of errors in observations and blended products: 1) random error; 2) sampling error; and 3) bias error. The bias error is the systematic difference between one instrument (or a set of instruments, e.g., in-situ observations) and another (e.g., remote sensing/satellite observations). The combined error for all terms should be reduced to a required accuracy for meaningful climate change diagnostics. In the satellite era, satellite observations provide dense data coverage, thus in-situ data play a minor role in the reduction of random and sampling errors and in increasing resolutions in blended products. However, in-situ observations provide the "ground-truth", thus play an essential role in correcting the systematic biases of indirect measurements (e.g., remote sensing/satellite observations that are calibrated to in-situ observations).

The overall objectives of this project are: 1) to ingest the world's marine observations into the NCDC archives; 2) to quality control the data for various applications (such as for Reanalysis); 3) to produce blended products for optimal use of all the observations; and 4) to improve services for a wide variety of user communities. The highlighted tasks and deliverables for this fiscal year are detailed in the next section.

2. ACCOMPLISHMENTS

2.1. ICOADS - Access to historical records; Expanded GIS functionality

As the result of a US project starting in 1981, available global surface marine data from the late 18th century to date have been assembled, quality controlled, and made widely available to the international research community in products of the Comprehensive Ocean-Atmosphere Data Set (COADS). A new name, International COADS (ICOADS), was agreed upon in 2002 to recognize the multinational input to the blended observational database and other benefits gained from extensive international collaboration. NCDC continued to ingest, archive, quality control and serve the ICOADS data (http://www7.ncdc.noaa.gov/CDO/CDOMarineSelect.jsp).

Improved data model has been developed to accommodate access for the entire ICOADS data archive (Figure 1). Additional quality control code is being applied prior to database loading. A prototype GIS system has been completed.

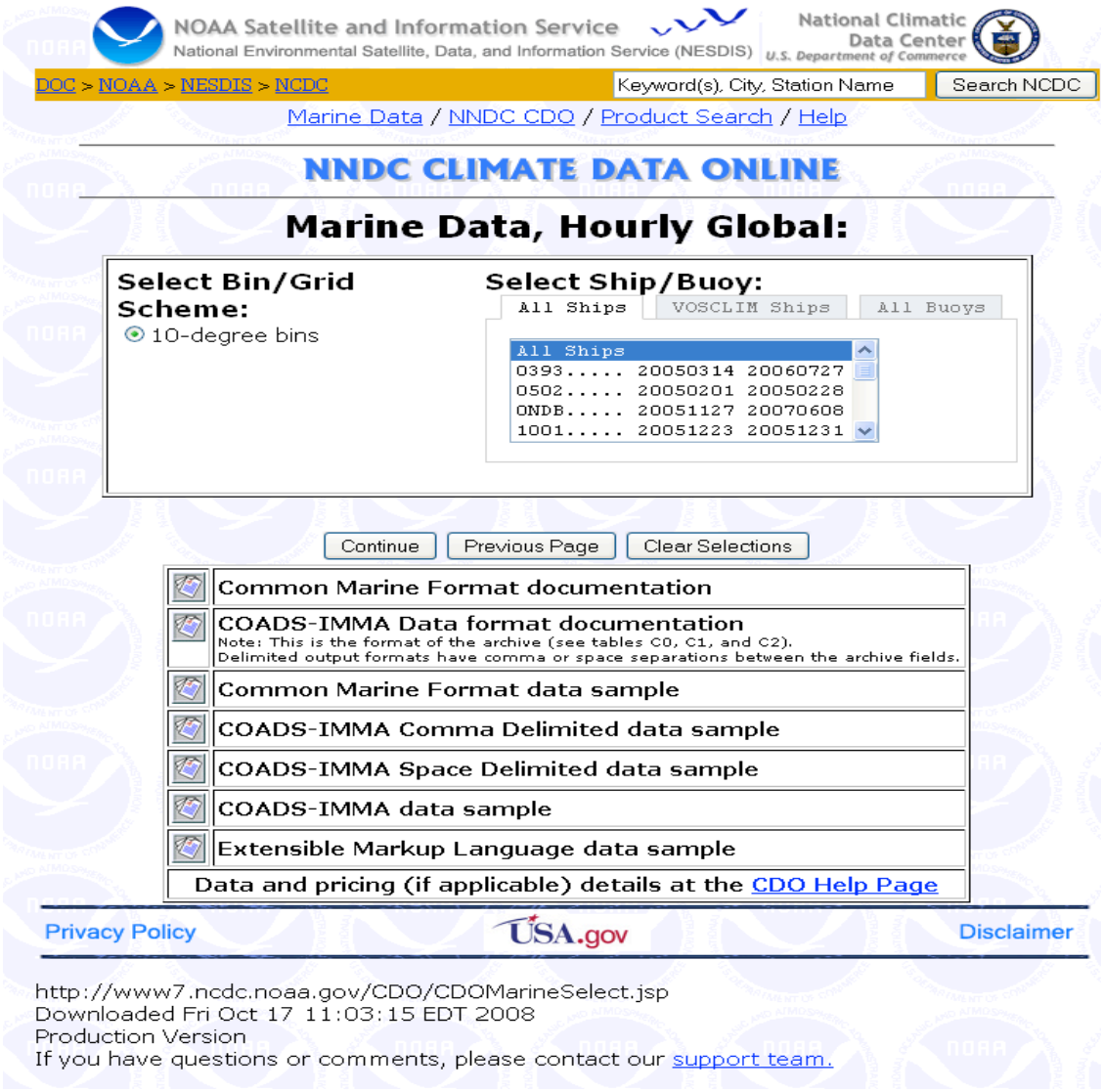


Figure 1. A screen capture of the Climate Data Online (CDO) for the global hourly marine observations.

2.2. VOSClim

VOSClim is an ongoing project within WMO/IOC JCOMM's Voluntary Observing Ships' Scheme. It aims to provide a high-quality subset of marine meteorological data, with extensive associated metadata, to be available in both real-time and delayed mode to support global climate studies. Data from the project are invaluable for climate change studies and research. In particular it is used to: 1) input directly into air-sea flux computations, as part of coupled atmosphere-ocean climate models; 2) provide ground truth for calibrating satellite observations, evaluating and validating NWP model and reanalysis results; and 3) provide a high quality reference data set for possible re-calibration of observations from the entire VOS fleet. As the VOSClim Data Assembly Center (VOSClim DAC), NCDC continued to ingest, archive, quality control and serve the ICOADS data.

Additionally, we maintained the VOSClim website. In doing this, we updated the monthly ship monitoring statistics and list of participating ships (Figure 2), and provided access to the VOSClim data. The data is provided through database access as well as ASCII text files supplied through pull down menus, as recommended by VOSClim partners and scientific users.

ASCII data access is considered of more utility for the current level of scientific and general users and therefore is a critical addition. Drop down menus for access to monthly data monitoring statistics are provided as well as links to ship photographs and other metadata information. There are currently 258 active VOSClim ships, which surpasses the initial project target of 200 participating vessels.

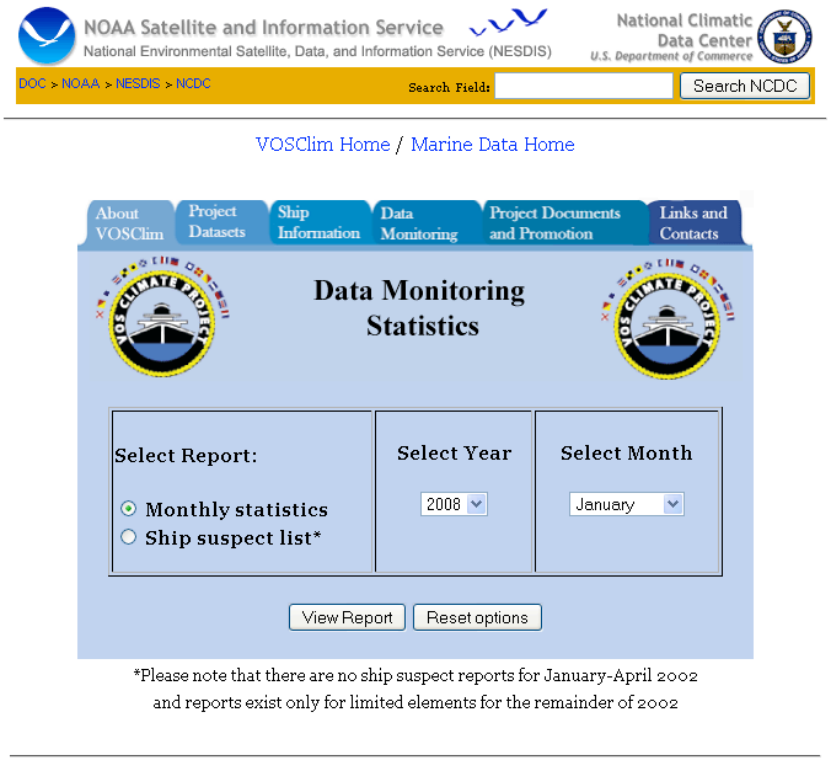


Figure 2. VOSClim's Data Monitoring webpage (http://www.ncdc.noaa.gov/oa/climate/vosclim/vosclim-stats.html).

Beginning in 2008, NCDC assumed duties previously provided by the Global Collecting Centers (GCCs) to collect VOSClim observations from global delayed-mode data files. Software was created at the DAC to parse the observations from the GCC quarterly data files and generate a report with statistics. The statistics are supplied each quarter to the GCC's for their annual report and the observations are made available through the VOSClim website.

2.3. Improvement of Blended High Resolution Sea Winds

The importance of production of air-sea interface products has been stipulated in the previous section (Project Summary). Our blended sea winds have been used by a wide variety of communities, including climate research, decision making & planning, wave hindcasting &

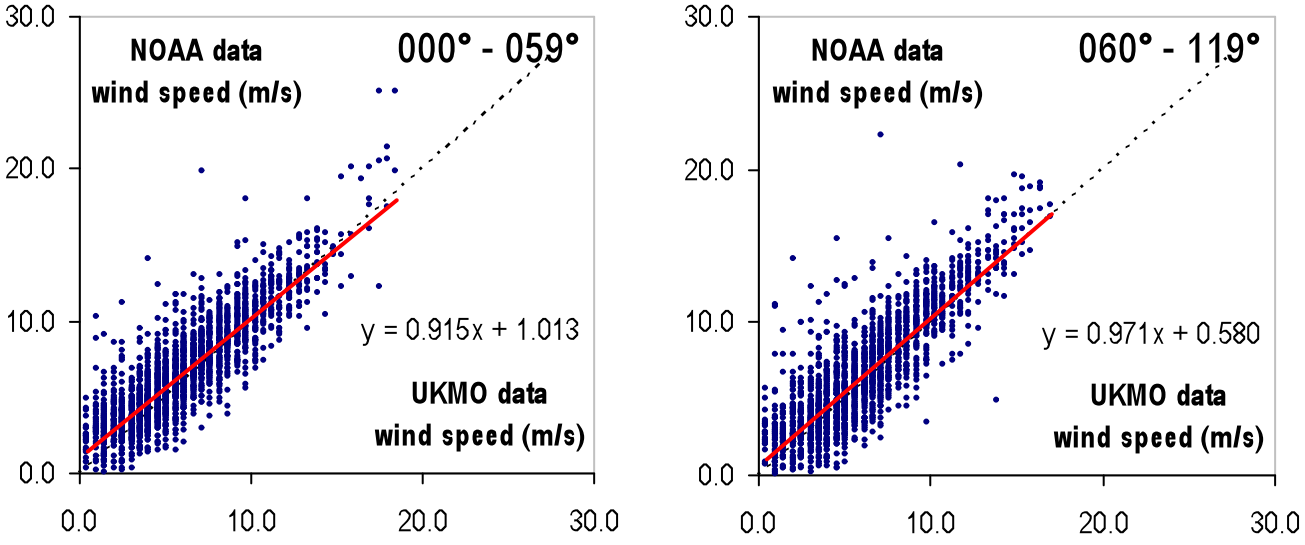
forecasting, ecosystems, marine resource management, marine transportation, wind/wave energy harvesting, and outreach & education. In this year, we have completed the following tasks:

a) Operational production and service of the blended 0.25°, 6-hourly sea winds

In the previous year, we had developed the procedures to generate the blended sea winds on a global 0.25° grid and 6-hourly time resolution. In the last year, we continued such products with an update frequency of about one month. We continued the data service via the interactive web interface (see links at http://www.ncdc.noaa.gov/oa/rsad/blendedseawinds.html).

b) Product evaluation for product improvement

In this year, the evaluation process for our blended products has been started. An example is shown in Figure 3 from the UK Met Office. Other evolutions have been started at the NOAA NCEP, the Scripps Institution of Oceanography of University of California at San Diego, the Aerospace & Marine International (UK) Ltd, and others.



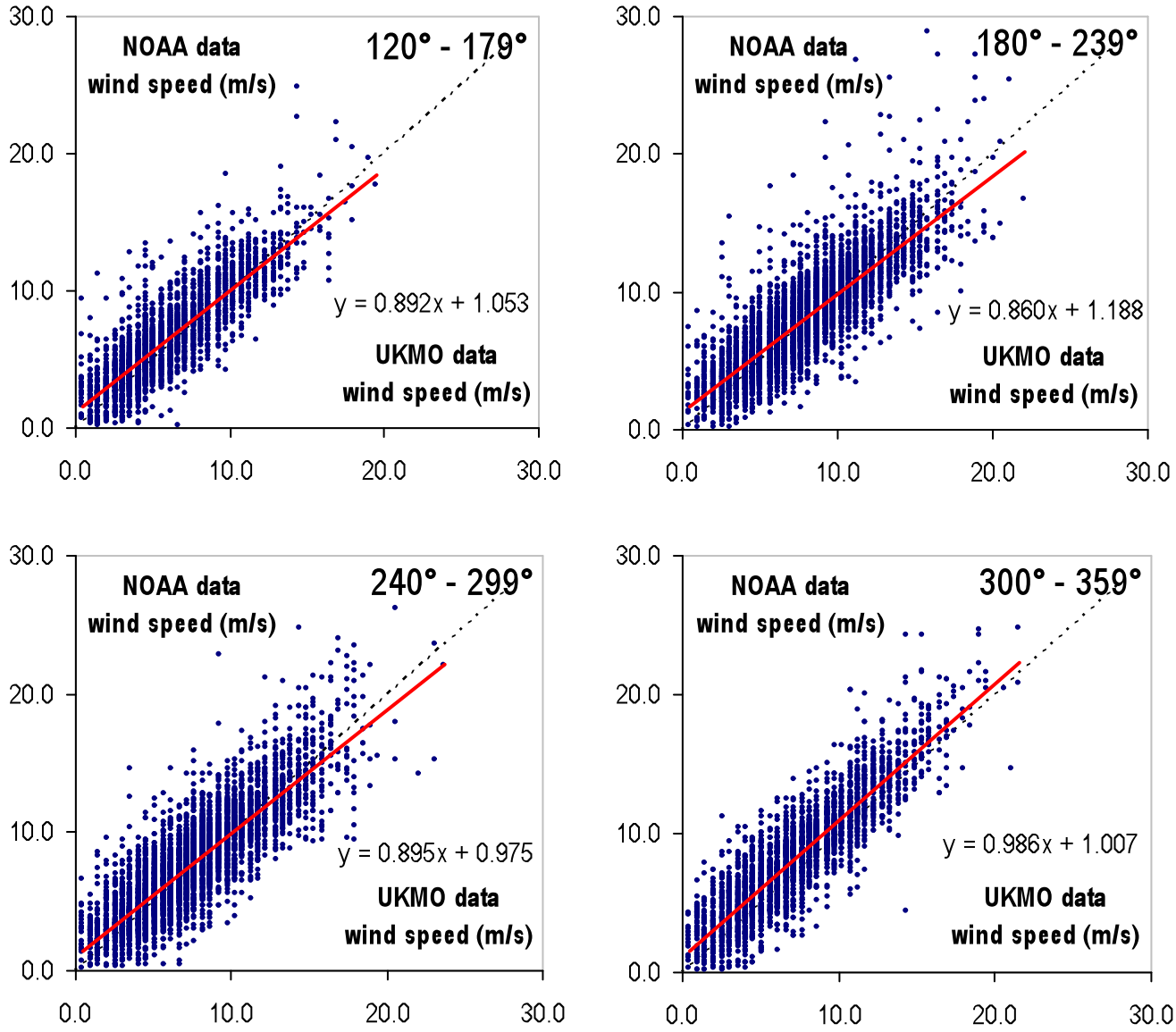


Figure 3. Comparison of directional wind speed data – UK Met Office Model predictions and NCDC Blended Sea Winds data from multiple satellites. Note the Met Office winds are at 20m and NCDC winds are at 10m above the mean sea level; better agreement could be achieved when the winds are corrected to the same height (from Richard Swift for UK Met Office Marine Data Analysis).

3. PUBLICATIONS AND REPORTS

Zhang, H.-M., R.W. Reynolds, L. Shi, A. Hall, E. Freeman, R. Baldwin, and A Fotos, 2008: Integrated In-Situ and Satellite Surface Marine Observing System, Datasets and Management at NCDC. *NOAA Climate Observation Division 6th Annual System Review*, 3 -5 Sept 2008, Silver Spring, MD.

Zhang, H.-M., R.W. Reynolds, R. Lumpkin, R. Molinari, K. Arzayus, M. Johnson, T.M. Smith, 2008: An Integrated Global Ocean Observing System for Sea Surface Temperature Using Satellites and In situ Data: Research-to-Operations, *Bulletin of the American Meteorological Society,* (Dec 2008 issue), DOI: 10.1175/2008BAMS2577.1.

Anderson, D. and H.-M. Zhang, 2008: Shallow ocean overturning and the heat and carbon content of the Glacial Tropical Ocean. G*lobal and Planetary Change*, submitted.

Huai-Min Zhang, Richard W. Reynolds, Lei Shi, and John J. Bates, 2008: Blended High Resolution Sea Surface Flux Parameters from Multiple Satellites. *FLUXNEWS – Newsletter of the WCRP Working Group on Surface Fluxes*, Issue 5, Jan 2008, pp. 25-27.

Zhang, H.-M., R. W. Reynolds, G. Rutledge, R. Mendelssohn, F. Schwing, L. DeWitt, and D. Swank, 2008: Multi-Satellite Blended Surface Marine Products and Their Applications. *ASLO/AGU/TOS/ERF 2008 Ocean Sciences Meeting - From the Watershed to the Global Ocean*, 2-7 March 2008, Orlando, Florida, USA.